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ABSTRACT

The role and contribution of academic science to national development in the Republic of Korea is discussed. After an overview on the development of the Korean system of higher education, attention is directed to the national research system and its articulation with the academic system. Consideration is given to: factors that contributed to the expansion of higher education in Korea; the predominant role of private higher education institutions; the curriculum of four-year colleges and universities; government involvement in academic administration; the planned change of emphasis in undergraduate education from the humanities and social sciences to the natural sciences and engineering; strategies for faculty development; and characteristics of graduate education. It is planned that research in the academic system be expanded to promote science and technology idea creation and assessment and validation of these ideas. The following changes are needed: increased allocations of research funds to university and college scientists; integration of developmental research into the traditionally basic research-oriented community; and improvement in the quality of research. (SW)

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SCIENCE AND HIGHER EDUCATION IN KOREA

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SCIENCE AND HIGHER EDUCATION IN KOREA

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This paper discusses the state of academic science – its role and contribution to national development in the Republic of Korea, a newly industrialized country, from two points of view. The first section constitutes a general introduction to the contemporary state of higher education. The second section investigates the national research system and its articulation with the academic system.

STATE OF HIGHER EDUCATION

Development of Higher Education

The modern Western-type higher education in Korea began to develop with the arrival of Western missionaries in the 1880's. Their strategy was to initially establish secondary schools and then to elevate their level to higher education. At that time, there was no established form of higher education in Korea, even though some institutions covered the instruction and the students at the postsecondary level. The American missionaries initially upgraded their schools to junior colleges and eventually turned them into Western-style four-year institutions of higher education. The earlier American missionary efforts through establishment of the institutions of higher learning were very successful, not only in proselytizing on behalf of the Christian faith, but also in introducing the structure and content of Western higher education. This influenced the development of a democratic ideology of freedom and independence and spread the idea that education was for everyone. The early American missionaries brought more than just establishment of the institutions of higher learning and a concern for curriculum and instruction for young Koreans. For example, they brought modern scientific curricula and educational methods to Korean higher education. Of course, the early American missionaries had to confront nationalism and reform movement by the indigenous group. Due to the fact that American missionaries were foreigners, outsiders, and representatives of Western influences, they were seemingly rejected by the indigenous group. However, both

sides shared a number of common beliefs and practices. They pushed together toward the independence and self-determination of the Korean people. They were against governmental authoritarianism which in later years was more strengthened by the Japanese aggressors. According to Insoo Sohn, between 1885 and 1910, a total of 796 schools from elementary to college levels were established and maintained by the Western missionaries. This is a significant number as it comprised about thirty-five percent of the entire number of formal schools in Korea.[1]

The development of higher education in Korea during the thirty-six years of Japanese occupation (1910-1945) was extremely retarded. Very few opportunities for higher education were given to the Koreans, compared those given to the Japanese living in Korea. Under the Education Ordinance of 1911, the early institutions of higher education established by the American missionaries lost their college status. A movement by the Korean nationalists to establish their own private university was turned down. Rather, the Japanese regime opened the Keijo Imperial University in Seoul in 1924 and made it the only university in Korea, while all the other established institutions of higher learning were downgraded to three-year non-degree granting institutions. The founding of Keijo Imperial University could be interpreted as a positive step in that it was another modern-style four-year university in Korea. The number of Korean students admitted, however, was strongly restricted to between one-fourth and one-third of the total number of students. In addition, the Japanese began to interfere with the Christian mission schools and institutions of higher education in every conceivable way.

When Korea was liberated from the Japanese colonial rule in 1945, there were only 19 institutions of higher education which accomodated 7,819 students and 753 faculty members. During the past four decades, however, the Korean higher education system has experienced rapid growth in its quantity. The wave of quantitative growth is really now cresting. The total number of institutions of higher education had increased to 256 by 1986: 1) 120 two-or three-year junior vocational colleges, 2) 111 four-year colleges and universities, and 3) 25 miscellaneous postsecondary schools. The total enrollment in these institutions amounted to 1.33 million in 1986, which accounted for about 3.2 percent of the entire population. The enrollment in the various types of higher education institutions in 1986 exceeded thirty-seven percent of the total Korean population aged 18-21, while about twenty-nine percent of this age group were enrolled in four-year institutions of higher

education[2]. This is a higher ratio of enrollment than many developed countries and some newly industrialized countries. The enrollment in higher education institutions per 1,000 total population in Korea was about 31.1 in 1985, which was lower than that of the United States(54.9 in 1981) but much higher than that of Japan(20.2 in 1982), West Germany(21.2 in 1982), Singapore(12.6 in 1984), and Taiwan(21.6 in 1984).[3] To use Martin Trow's term, Korean higher education has already passed the threshold of an elite system, and during this decade it will be in the midst of a mass system in terms of percentage of enrollment by the eligible age group.[4]

To sketch the development during the past four decades of the Korean system of higher education, particularly focusing on the four-year undergraduate education, six particular features stand out. First, several factors contributed to the expansion of higher schooling in Korea. Examples include the continued rise in the birth rate since the Korean War, and the social and national demand for the levelling-off of enrollment in regional distribution, in the public and the private sectors and in the academic disciplines. Another force was the continuing emergence of new major fields in the world of knowledge and new jobs in the world of work. However, the most salient factor must be the traditional value orientations of Koreans who view higher education as a valuable means for socioeconomic mobility.[5] Under the Japanese rule, opportunities for higher education for Koreans were severely limited. When the Japanese occupation was over, the tremendous zeal for higher education, especially widespread among the middle and upper class, resulted in a mushrooming of colleges and universities, most of which were founded by private organizations.

Secondly, the private institutions of higher learning outnumber by far the public ones, enrolling more than three quarters of all students. In 1945, the difference was slight, 40.9 percent for the public but 59.1 percent for the private sectors.[6] Toward the 1960's, however, the number of private institutions of higher education multiplied rapidly. In the midst of the national movement toward economic, social and political reconstruction of the country ruined by the Korean War, many leaders in private organizations invested their resources in establishing institutions of higher education. On the other hand, it was also true that some of these colleges and universities were established only for the purpose of profit-making, which is why the government began to employ a strict quota system in enrolling students in

institutions of higher education from the mid-1960's under the Park's regime. Nevertheless, no one can deny that, since the 1960's, the private institutions of higher education have made a considerable contribution to the development of high level human resources in Korea. Not all, but many private institutions of today are faced with such very serious problems as quality of education and financial constraints. These problems are even more pressing for the private institutions, as they rely on students' tuition to cover more than seventy percent of their expenses, while only about fifty-four percent of the budget in public institutions is covered by students' tuition.[7]

The third feature is the curriculum of four-year colleges and universities. The baccalaureate degree requires at least 140 credit hours, thirty-two percent of which are devoted to the general education. In addition to the semester system, the major-minor and double-major system were employed through the experimental pilot institute program in 1973. An advanced placement program for superior students in some general education subjects through institutional examinations was also introduced. In 1984, summer sessions were universalized and are now present in every four-year institution of higher education. The major problems faced in the area of curriculum include the neglect of general education as peripheral and the departmentally fragmented and overspecialized specialty education. At the undergraduate level, there are now 322 different kind of major departments but the baccalaureate degrees in terms of their nomenclature are only 25 kinds. Fragmentation in majors is much stronger in natural sciences & engineering and arts & physical education fields than in other fields. On average, there are about ten departments in each kind of major. Of today, many faculty members and students as well as administrators have voiced legitimate concerns over curriculum development in Korean universities and colleges, criticizing that a major has been a simply collection of courses in a certain specialty area lacking balance or cohesion between depth and breadth.

Fourthly, for a long time, a salient feature of the Korean system of higher education has been the direct government involvement in its academic administration of higher education. In an attempt to assure quality control, the government has directly participated in accrediting institutions, faculty and programs. There has been, however, an urgent demand for a new strategy of development to rejuvenate the institutions of higher education through mobilizing academic expertise. This

trend collectively culminated in 1982, when a non-governmental and collective body of four-year institutions of higher education, dubbed as the Korean Council for University Education, came into being. The primary function of the Council is to insure a basic level of quality and considerable independence and autonomy through the practice of professional evaluation of higher education institutions and programs. The primary mode of evaluation is the same as that of the accrediting system prevalent in the United States. Since its establishment, the Council has conducted such institutional and programmatic evaluations every year.

The fifth feature of the development of Korean education during the past four decades is its planned transfer of emphasis in undergraduate education from the humanities and social sciences to the natural sciences and engineering. The teaching and learning in Korea's traditional Confucian society had embraced only letters, along with a deep-rooted value orientation of the people for "culturati". However, entering the 1960's, Koreans awakened to the realities of the times. The government, launching the first Five-Year Economic Development Plan in 1962, adopted an innovative policy emphasizing higher education in the natural sciences and engineering fields, which has continued up to now. In putting into effect such a policy, the government has moderately increased the enrollment quota in the science and engineering fields in institutions of higher education every year, while limiting the increases in the humanities and the social science fields. Statistics show marked changes in enrollment since the 1960's. In 1965, enrollment in the science and engineering fields in four-year institutions of higher education accounted for 44 percent of the student population, and it exceeded 50 percent for a time in the 1970's. It dropped to 47.5 percent in 1980, and according to the freshman enrollment quotas in 1987, the science and engineering fields occupied 36.1 percent. It is interesting to note that of the students majoring in science and engineering, about 58 percent are enrolled in the engineering fields, 28 percent in the pure natural sciences such as mathematics, chemistry and the like ones, 12 percent in agriculture and forestry, and 2 percent in fishery and marine science.[8]

One final feature to be noted is faculty development. Since the mid-1960's, not only the government but also each individual institution has designed various strategies to develop faculty resources, particularly to help faculty members earn doctoral degrees. In 1967, the number of faculty members holding doctoral degrees in four-year institutions amounted to only 10 percent.[9] By 1983, this figure had

increased to about 40 percent.[10] Now, a Ph.D. is a prerequisite for employment as a faculty member in most four-year universities and colleges. Concerning the doctoral degrees of faculty members, two additional observations can be made. First, we may note the countries where the degrees were earned. According to a survey conducted in 1983, about 61 percent of doctoral degree holders earned their degrees from domestic institutions, 22 percent from North American institutions, 9 percent from European and 8 percent from other Asian institutions. The other interesting observation is the different ratio of doctoral degree holders in different fields. Almost 50 percent of the faculty members in science and engineering hold doctoral degrees, which is much higher than the national average, but less than 40 percent do in the humanites and social science fields. It is also interesting that the ratio of doctoral degree holders who earned their degrees in advanced foreign countries is much higher in the science and engineering than in the humanities and social science fields.[11] Since the beginning of the 1980's, the government has allocated a considerable amount of its budget for faculty development, which has enabled professors to have a one-year paid leave to pursue an educational or research program in a foreign country. Here as well, more priority is given to professors in the science and engineering fields than those in the humanities and social science fields.

Graduate Education

In Korea, the graduate education began to be recognized when the masters degree was conferred upon ninety students of Seoul National University in 1949 for the first time.[12] Before the mid-1960's, however, the graduate program was quite underdeveloped. At the very beginning, it was modeled after the Japanese system, which was originally based on the German System. Graduate education following the American model began to develop when Yonsei University opened a new American-styled doctoral degree course in 1961 and conferred the doctoral degree upon three medical graduate students in 1965.[13] During the next two decades, the graduate education in Korea witnessed enormous advances in size, structure and function. The number of graduate education institutions rose from 37 in 1965 to 203 in 1986, a more than five-fold increase, while the number of students made an 18-fold increase, reaching about 70 thousand students enrolled in 1986.

Korea's graduate schools of today are divided into two types: academic graduate

schools, which are research-oriented and offers masters and Ph. D. degree programs, and professional graduate schools, which emphasize practical experience or professional knowledge, and offer only masters degree programs. As of 1986, there were 77 academic graduate schools (15 public and 62 private), and 126 professional graduate schools (29 public and 97 private), which include 34 graduate schools of education, 22 of business administration, 17 of public administration, 13 of engineering, 9 of theology, and 31 others. In the academic graduate schools, more than 30 thousand graduate students are working for masters degrees and more than 10 thousand for doctoral degrees. In addition, in the professional graduate schools, about 29 thousand graduate students are working for masters degrees. In terms of enrollment, the natural sciences and engineering fields account for about 40 percent of the students in masters degree programs and 36 percent of those in doctoral degree programs in the academic graduate schools. However, the professional graduate programs in the natural sciences and engineering fields are not as well developed as those in the academic graduate schools. The number of programs as well as the enrollment size in the natural sciences and engineering fields in the professional graduate schools is less than 10 percent of the total.

Analysis of the current graduate education system in Korea makes it possible to note some characteristics. First, according to the current Education Law, the number of different master degrees in use is only twenty-seven, and only nineteen different doctoral degrees can be earned. However, there are a variety of different programs; at least 278 different department-based specialty areas are established in Korean graduate schools.[14] This fact simply suggests that the current nomenclature of the different degrees is not appropriate to fully designate in which specific field the conferred degrees are specialized. In addition, the academic research-oriented masters degree and the professional or practitioner masters degree cannot be distinguished by their nomenclature. As these two degrees have a different emphasis and dominant characteristics, these distinctions should be expressed in the terminology used.

Secondly, the education in academic graduate schools is patterned after the American system in its outward appearance, but the Japanese system, which is an apprentice mode, is still present in its hidden operation. The procedure of conferring degrees is quite similar to that of American graduate schools. For example, course requirements, qualifying examinations, requiring two foreign languages, thesis writing

and oral defenses are all standard practice in Korean graduate education. Many critics have raised the issue that the current academic graduate education does not allow for both specialization, or concentration, and breadth. Since the number of credits required is smaller than that of the American graduate schools: only 24 credits for a masters degree and 36 additional credits for a doctoral degree. It may be true that with this small number of course requirements, neither narrow specialization nor emphasis on breadth is possible. However, it should be noted that many students in academic graduate schools work in their professors' offices and/or laboratories under their direct supervision and guidance. They assist in the research projects led by their professors as well as their undergraduate teaching. They are often paid but not always. Through this process of apprenticeship, the students learn not only scientific knowledge but also cultivate a scholarly attitude. This sort of invisible, hidden curriculum is often more influential to the graduate students than the overt required course-works.

The third and more important characteristic of Korean graduate education is its role in research. From the beginning, the graduate schools in Korea have been identified with the "research" mission of higher education. It is still easy to find some evidences of this role in the current graduate education system. For example, it is the graduate school in most institutions of higher education which plays the role of adminstrative center, managing all the research funds for faculty members. The teaching and learning in the graduate schools is highly dependent upon the research achievements of the faculty members. They bring their research findings into the classroom and also attach heavy weight to their responsibilities in advising the students' thesis writing. Research has been regarded as the loop which links the professors with the graduate students as well as the professors with one another. The graduate schools in Korea, as in other countries, have been the most productive system in providing research personnel to society. By 1987, a total of 15,735 students had earned doctoral degrees from all the Korean graduate schools.[15] The number of doctoral degrees earned per 10,000 total population increased from 0.35 in 1965 to 4.48 in 1986, showing very impressive growth.[16]

However, the Korean graduate education has been faced with problems of disproportion. For example, there has been a severely disproportionate production of doctoral degrees in a few major fields. The majority of domestically-earned degrees were in the medical sciences. Now, the situation is greatly improved but even a

decade ago, the number of domestic doctoral degree holders in the humanities, social sciences, natural sciences and engineering fields was easily countable. This has a close relation with the professors' attitude toward graduate education. Traditionally, Korean faculty members have highly regarded apprenticeship, which encouraged them to hold their students for longer before giving them their doctoral degrees. This might be one of the major reasons why so many bright, young students have sought their degrees in advanced foreign countries, particularly in the United States, where they have only to follow the defined track for a certain time. The disproportion of doctoral degree production by fields is still conspicuous. In 1986, 30 percent of the conferred doctoral degrees were in the medical sciences, while only 18 percent were in engineering.[17] Another disproportion is the faculty organization of undergraduate-department based. Few graduate schools have their own full-time cadre of faculty of sufficient scholarly stature and experience. Their teaching and advising graduate students may be seen as simply an additional load or an extra-income source to their normal undergraduate teaching. This organizational system centered on undergraduate education has resulted in much slower growth of graduate education than in undergraduate education and, what is worse, graduate education of poor quality. One more problem is that the granting of doctoral degrees has been the sole business of only a few institutions. Forty-eight percent of all doctoral degrees conferred in Korea by 1987 were earned at only the four leading universities: Seoul National, Yonsei, Korea, and Kyungbuk National.[18] It is also interesting to note that the tendency of inbreeding in these leading universites has been relatively higher than other institutions. It is widely perceived that gaining admission to doctoral degree programs and later getting faculty positions in such institutions is quite difficult unless the applicants are alumni of those institutions.

Responding to these long-latent problems and recognizing the national demand for highly advanced research personnel in various fields, many measures have been initiated during the past decade. The government has allowed the establishment of new graduate schools in many institutions of higher education and has increased the enrollment quotas in the well-established graduate schools. In particular, two meaningful developments are worth noting. One is the long-term plan to restructure Seoul National University, as a graduate education centered institution, minimizing the role and burden of its undergraduate education. The other is the establishment of the Korea Advanced Institute of Science and Technology(KAIST), which is

a state-run graduate institution in the science and engineering fields. KAIST was founded in 1981, uniting two institutions: the Korea Institute of Science and Technology founded in 1966 and the Korea Advanced Institute of Science founded in 1971.

SCIENTIFIC RESEARCH SYSTEM

National Research System

The national science and technology research system in Korea has been active since the mid-1960's. Some historical developments include the establishment of the Ministry of Science and Technology in 1967 as the central agency for the administration of scientific and technological development. For the past two decades, the Ministry has throughly developed its policies on science and technology and has reorganized its basic organization. Since 1974, the government has built the Daeduk Science Town, an international scale technopolis in the nothern part of Daejeon City, 150 km south of Seoul. Not only government-funded research institutes including KAIST, but also private research institutes have moved into the Town; consequently it has become a huge research complex in which research facilities, personnel and information as well as ideas for research are shared. Another important historical development was the promulgation of the Technology Development Promotion Law in 1972. Since this time, private industries have put more effort into establishing their institutional infrastructure and developing manpower through the various tax incentives and financial support provided through this law.

To sketch the current R & D situation in science and technology in Korea, as of 1984 there were 648 R & D related institutions excluding those in medical science area, 37,103 researchers, or 0.92 persons per 1,000 population, and the total R & D investment was 1,008 million US dollars, or 1.28 percent of the GNP.[19] To look into more detail, first, among the R & D related institutions, nearly seventy percent were established by private companies, while the governmental institutions account for only eleven percent and the R & D institutions affiliated with universities and colleges make up about nineteen percent. The proportion of the R & D institutions occupied by private companies has steadily increased since the 1970's. For example, it rose from 36 percent in 1970 to 55 percent in 1975, then to 64 percent in 1982, and finally to 69.6 percent in 1984.[20] Such an increase indicates

a close relationship with the dramatic economic growth in business and industry since the 1970's, as well as with the governmental efforts to promote private technology through the above-mentioned Technology Development Promotion Law.

Secondly, however, more R & D personnel thronged to universites and colleges, considering their number of institutions, than to the R & D institutions of the government and the private companies. The Table 1 summarizes the distribution of R & D personnel in 1984. By the type of R & D institutions, about 44 percent of the R & D personnel are employed by private companies and about 38 percent by universities and colleges. In terms of field of research, a vast majority come from the engineering field. One of Korea's weaknesses is that it has only 15 percent of R & D personnel in the basic science fields such as mathematics, physics, chemistry and biology. Of all the R & D personnel, only 19 percent have doctoral degrees, 34 percent masters degrees, and 47 percent bachelors degrees or some other lower level certificates.

Thirdly, looking at the distribution of R & D expenditures, as indicated in Table 2, the private companies account for about 65 percent of the total expenditure, the institutions of higher education about 10 percent and the governmental institutions 25 percent. Almost eighty percent of the total R & D budget comes from the private sector, and twenty percent comes from the government. Also, more than half of the expenditure is invested in the developmental research. The area of basic research, which is claimed by many scientists to be a top priority, receives only 17 percent of the total.

It may be apparent from this brief informative description that Korea's strategy has been to oblige its R & D projects to depend on the private sector in terms of its institutions, personnel and expenditures. Notwithstanding the relative importance of universities and colleges as sources of R & D personnel education and training, the government seems to have paid more attention to the endogenous growth of the private sector in R & D endeavors. Of equal interest is the obvious emphasis on developmental research, which is probably due to the relatively high dependence of R & D on private companies. It has been assumed that the R & D institutions in universities and colleges prefer to work in basic research rather than in applied and developmental research. For this reason, the Korean Science and Engineering Foundation has continuously increased its financial support of R & D work in universities and colleges, particularly research work in the basic sciences.

Since 1962 to date, Korea has expanded its economy substantially and has industrialized its economic structure through the repetition of a five-year economic development plan. In 1987, the government initiated the Sixth Five-Year Economic & Social Development Plan, which will cover the five-year period until 1991. The Plan mainly focuses on promoting the following four goals with the basic aim of constructing a welfare society based on self-growth: 1) systematic development of an economically sound society and settlement of social stability on the basis of autonomy and an open-door policy, efficiency and social balance; 2) development of an active community with a well-balanced expansion of industrial development suitable to regional characteristics; 3) elevating social equity and enhancing social welfare by increasing the middle class and by raising the living standard of the lower income class; and 4) elevation of industrial efficiency by reorganizing the industrial structure and by attaining a technologically advanced society.[21] Along with this Plan, the Ministry of Science and Technology has prepared its own "Long-Term Plan of Science and Technology toward the Year 2000's" . According to this long-term plan, entering the Year 2000, Korea will be investing 2.50 percent of the GNP to R & D, with 1.50 R & D personnel per 1000 population or about one hundred thousand R & D persons.

The last thing to be noted regarding the national research system is the governmental policy on international technical cooperation. Three policy guidelines are set forth by the government: 1) the technical cooperation with advanced countries will be developed not only on a concessionary but on a reciprocal basis so that Korea can acquire the new advanced technologies needed for her industrialization; 2) Korea is interested in participating in international cooperative programs initiated by the U. N. organization in which the Koreans can exchange their development ideas and new technologies on a multilateral basis by increasing contributions in expert services and technical training; and 3) based on the spirit and principles of technical cooperation among developing countries aimed at establishing new international economic order through collective self-reliance among developing countries, the Korean government wishes to increase its technical assistance to developing areas to share its developmental experiences and technologies for the common prosperity.[22]

Articulation with the Academic System

The articulation between the national research system and the academic system has been crucial in accelerating the industrialization process in Korea. It seems that the academic system has been subjected to the national development strategy and its subsequent policy concerning the national research system. For example, Tai Won Park pinpointed the relationship between higher education and technological innovation in Korea as summarized in Table 3. In the 1960's, when the import-substitution strategy was replaced by export promotion based on a labor-intensive industrial structure, the higher education was forced to shift its goal for manpower training to technicians and low-end engineers. The acquisition and mere imitation of the science and technology in well-advanced countries was the basic mode education in science and technology in the institutions of higher education. However, the structural change in development strategy from light to heavy industry in the 1970's brought about an increased demand for engineers and research scientists in the academic system.

In brief, the new mission of the academic system to accomodate the expected change in industrial structure for the coming decade is to employ innovation and invention in order to generate endogenous technology in the national research system. This means, in other words, expanding the research function of the academic system, from the confines of pure basic research, to idea creation and its assessment as well as validity research of those ideas. The primary role of the academic system seems to expand endogenous sources of scientific and technological creations through promotion of production, assessment and validation of ideas.

The idea of the endogenous development of science and technology necessitates equally broad changes in the current academic system, such as in the following three specific examples. First, the total research funds allocated to university and college scientists must be proportionately expanded, to overcome the disparity with researchers in the private sector. As of 1983, the average research expenditure for one faculty member was only 15 percent of that received by one R & D scientist in business and industry. The state-supported R & D scientist receives on the average about 88 percent of the amount received by R & D scientist in business and industry. To cite some cases in foreign countries for comparison, the average individual research expenditure of university and college researchers compared to that of R & D scientists in business and industry is 91 percent in the United States (1980), 39 percent in Japan (1982), 86 percent in West Germany (1979), and 36 percent in France

(1979).[23] There are two strategies for attacking this problem which seem to be appropriate. One is to recommend that the government change its research fund support policy which has been one-sided, only for the benefit of governmental R & D institutes. The other is that the non-governmental sources of financial support, mainly private foundations, must also change their one-sided preference for the R & D enterprise in private companies. If these two giant sources of research funds pay more attention to the R & D personnel in universities and colleges, their practical commitment to R & D in their own fields will surely increase as well.

Secondly, the academic system is faced with a strong demand to appropriately integrate developmental research into the traditionally basic research oriented community. For example, in 1984, the distribution of research funds in universities and colleges was 53.5 percent for basic research, 35.3 percent for applied research, and only 11.2 percent for developmental research.[24] The importance of pure fundamental research has long been a symbol of the institutions of higher education. The proof could not be more convincing, however, that such basic research should be advocated at the expense of developmental research. In a sense, in this post-industrial era, universities and colleges can no longer exist simply as an ivory tower but must be the center of the gravity of think-tank for scientific and technological development.

Thirdly, the academic research system should make an effort to improve the quality of their research. Although it is difficult to assess the quality of research, one rather dubious measure of its quality is the extent to which a scientist's work is recognized internationally. In 1983, Korean scientists contributed only 0.05 percent of the papers published in internationally recognized journals.[25] Based on this evidence, the Korean research community is still making only a very slight contribution. Another indirect index for evaluating the quality of research work is how the research projects are screened and supported by the visible college of the scientific community. It is very common in developed countries for the scientific community's visible and invisible colleges to be a complex organization. The fractious visible college acts as a pressure group on society and as a government critic and advisor. A more important function, however, is the internal stimulation and criticism among the members of their research teams. When they lose their self-integrity through quality control, the scientific push toward national development in science and technology may be replaced by the technological pull initiated by

the private industrial sectors. The most important point here is that an improvement in the quality of an academic system means much more than establishing a balanced mechanism of technological pull and scientific push. Academic systems are no longer subjective and no less are they closed within their own traditional territory. Thus quality itself is the strongest base on which the academic system can stand firmly.

CONCLUSION

This paper has been an introduction to the condition of Korean higher education and its research environments, more an interpretation than a recommendation. But certain recommendations are perhaps implicit in the interpretation. It is now appropriate to proceed with a recapitulation of the main components of that diagnostic interpretation.

It has been noted that since the mid-1960's much attention has been paid to the possible contributions of science and technology to Korea's national development. In only two decades, the Republic of Korea has come to be recognized world-wide as a newly industrialized country, but a wide gap still exists between the forerunners in the industrial world. The institutions of higher education started as a means for the cultural and social mobility of individuals but their collective power has been the primary force in bringing about economic growth through technological developments. Mostly, however, the technological development was achieved by the process of acquiring and/or imitating that of well-advanced countries. The crucial task of future developing science and technology in Korea is endogenous in nature, and requires innovation and creation, particularly considering Korea's extreme deficiency in natural resources.

As examined before, the research environment and the relationship of the academic system to society needs to be shaped by anticipating the problems of the coming years. In reorienting the scientific and technological policies in Korea, three facts must constantly be borne in mind. One is that in the future Korea is likely to depend more on high-level science and technology than on the low-level directly related to production or income-raising. Another is that Korea will be faced with strong offset policies by the well-advanced countries. The third, then, is that Korean science and technology must contribute to world development, particularly in assisting the third world countries or the less-developed countries.

Bearing these trends in mind, the following conclusions are evident. First, the role of science and technology in national development will be further expanded and strengthened with the continuous growth in R & D investments, personnel and institutes. Along with this progress, the role of institutions of higher education must be further extended; namely to produce high level R & D personnel and to partake in the national R & D enterprise not only through fundamental research but also through applied and developmental research. Second, the common goal of various types of R & D institutes, whether governmental or private, will be focused on the endogenous development of science and technology. Thirdly, in obtaining the status of an industrialized country, Korea must initiate policy changes to stimulate transnational R & D enterprise and finally the international transfer of science and technology through the visible and invisible colleges in the academic community of the world. To do this, first, there must be a restructuring of relationship among the three R & D communities – the governmental, the universities and colleges, and the private companies' R & D institutes. Also, Korea's international scientific and technological relations need to be re-patterned. Under the current circumstances, some policy-maker could be, but need not be a frustrated equilibrist seeking a delicate balance among all these goals. Perhaps all three goals can and will be achieved in an innovatively reshaped higher education that is evolving together with the splendid political development which is being realized, just like Korea's recently achieved economic growth.

NOTES:

1. Insoo Sohn, Hankook Kyoyooksa [History of Korean Education], 2 Vols. (Seoul: Muneumsa, 1987), Vol.2, pp.548-563.
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Table 1. Distribution of R & D Personnel (1984)

By Type of R & D Institution	Gov't Inst.	Higher Edu. Inst.	Private Companies
	18.9%	37.5%	43.6%

By Major Field	Basic Science	Engineering	Agriculture	Medical Science	Others
	15.3%	55.2%	10.1%	14.6%	4.8%

By Degree	Doctor	Master	Bachelor	Others
	19.1%	34.3%	41.8%	4.8%

Source: Ministry of Science & Technology, The 1985 Yearbook of Science and Technology(Seoul: MOST, 1985).

Table 2. Distribution of R & D Expenditures(1984)

By Type of R & D Institution	Gov't Inst.	Higher Edu. Inst.	Private Companies
	24.6%	10.5%	64.9%

By Source of Funds	Gov't Sector	Private Sector	Foreign Countries
	20.6%	78.6%	0.8%

By Type of Research	Basic Research	Applied Research	Development Research
	17.0%	28.7%	54.3%

Source: Ministry of Science and Technology, The 1985 Yearbook of Science and Technology (Seoul: MOST, 1985).

Table 3. Higher Education and Economic Development: A Synoptic View of Mutual Relationship

Period	1960's	1970's	1980's	1990's
Industrial Structure	Labor-intensive light industry	transition from light to heavy industry	heavy and high tech industry	heavy industry with specialization/ high tech industry
Patterns of Technology Transfer	foreign aid and technical assistance/ labor intensive technology/ unilateral transfer	transfer of sunset technology/ transition from labor to capital intensive technology/ dependent transfer via vertical international division of labor	transfer of maturned and advanced technology/ capital and knowledge intensive technology/ dependent transfer via vertical and horizontal division of labor/ foreign direct investment	transfer of technology in early stage of development/ via cross licensing, joint venture, and research collaboration/ knowledge intensive technology/ horizontal generation of endogenous technology
Educational Emphasis (manpower targets)	technicians and low-end engineers	engineers and research scientists	scientists and research engineers	scientists and research engineers
Qualitative nature of science and technology education	absorption and imitation	imitation and improvement	creative assimilation and innovation	innovation and invention

Source: Tai Won Park, "Higher Education and Technological Innovation in Economic Development of Korea", Pacific Focus, 1:2(Fall 1986), pp. 5-22. p.9.